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CURRENT MEASURING CIRCUITS

CLAIM(S)

A current measuring circuit for measuring a current flowing in a load by a voltage drop in the current detection resistor, by inserting the current detection resistor in the current path serial to said load contained in the constant voltage loop circuit for charging constant voltage into the load; said circuit being characterized in that it has a switching element for short-circuiting the current detection resistor inserted in said current path.

DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Application)

The present invention pertains to a current measuring circuit for measuring a load current by a voltage drop in a current detection resistor by charging constant voltage into the load via the current detection resistor.

(Prior Art)

In an IC tester, a current measuring circuit is used for measuring an in-flow current to an electrical power source pin of IC to be measured, and for checking a short-circuit and current leakage.

With a current measuring circuit of this type, the current detection resistor serially inserted in the load is generally contained in a constant voltage loop circuit for charging constant voltage into the load.

(Problems of the Prior Art to Be Solved)

When the load is capacitive in such a current measuring circuit, an eddy current flows at a time of charging voltage, but if the current is low, the current is limited since the value of current detecting resistor is high.

As a result, an operational amplifier and current booster (buffer) inside the constant current loop circuit reach saturation, making the measuring impossible.

Even when the saturation does not happen, it takes long time for the load current to be stabilized to a normal value, increasing the measuring time, which is a problem.

(Objective of the Invention)

Accordingly, the objective of the present invention is to present a current measuring circuit that solves the problems in measuring the current of capacitive load.

(Means to Solve the Problems)

To accomplish the aforementioned objective, the current measuring circuit of the present invention is characterized in that a current detection resistor is inserted in a current path serial to the load contained in the constant voltage loop circuit for charging the constant voltage in the load, and in that a switching element for short-circuiting the current detecting resistor inserted in said current path is installed in the current measuring circuit for measuring the load current by a voltage drop of current detecting resistor.

(Operation)

Even when the load is capacitive and has a low current range, the load eddy current will not be limited if the current detecting resistor is short-circuited by closing the switching element at the time of charging the voltage, and therefore saturation of the operational amplifier and current booster inside the constant voltage loop circuit can be prevented.

Also, the load current is stabilized to a constant value quickly, so if the switching element is opened after the time needed for this stabilization has passed, the current of capacitive load can be measured quickly.

(Embodiment)

An example of the embodiment of the present invention is explained with reference to the drawings.

Fig. 1 shows a circuit diagram indicating one embodiment example of the current measuring circuit of the present invention.

In the figure, 10 indicates the load the current of which is to be measured, and by the constant voltage loop circuit 12, the constant voltage V_1 is charged to measure the current.

This constant voltage loop circuit 12 has a general structure. More specifically, into the inversion input terminal of operational amplifier 14, the direct current voltage V_2 designated by digital signal 18 is charged from the digital/analog converter 16 via resistor 20, and the load voltage V_1 is fed back via the voltage follower and resistor 24 of operational amplifier. This non-inversion input terminal of the operational amplifier 14 is grounded. The output of the operational amplifier 14 is connected to the input terminal of current booster (buffer) 26 and its output is connected to the load connection terminal 28.

The gain of this constant voltage loop circuit 12 is determined by the resistors, 20, 24, and the load voltage V_1 is kept at a constant value proportionate to the current voltage V_2..

The current path serial to the load 10 inside the constant voltage loop circuit 12, in other words, in the area between the output terminal of current booster 26 and the load connection terminal 28, is inserted the current detection resistor. R_1- R_n are the current detection resistors.

As for the resistors $R_2 - R_n$, besides the resistor R_1 among the current detection resistors, one or more units are selectively inserted according to the measuring range. As the switching element for the selective insertion (measuring range switching), the lead relays, $RY_1 - RY_m$ are installed relative to resistors $R_2 - R_n$, as shown in the figure.

In this embodiment example, as the switching element for short-circuiting the current measuring resistors, $R_1 - R_n$, the lead relay RY_n is connected in parallel to the current measuring resistors, $R_1 - R_n$.

In the figure, 30 indicates the relay control circuit, which dynamically controls closing/opening of said lead relays, $RY_1 - RY_n$, according to the digital control signal 32.

In the figure, 34 indicates the operational amplifier for detecting the voltage drop in the current detection resistor. Into its non-inversion input

terminal, the output voltage from the current booster 26 is charged, and load voltage V_l is charged via the voltage follower of operational amplifier 36 into the inversion input terminal. The output voltage V_3 of operational amplifier 34 is proportionate to the load current.

With the current measuring circuit having this structure, the measuring operation is performed in the following sequence when the load 10 is capacitive.

When the prescribed voltage is charged into the load 10, the necessary RYs out of lead relays, $RY_1 - RY_m$, are closed by the lead control circuit 30 according to the measuring range, and one or more units out of resistors, $R_2 - R_n$, and resistor R_1 are connected in parallel and inserted in the current path. In a minimal current range, however, the resistor R_1 alone is inserted, and other resistors, $R_2 - R_n$, are not inserted.

At the same time, by the relay control circuit 30, the lead relay RY_n added for short-circuiting is closed.

Since the current detection resistor inserted in the current path serial to the load 10 is thus short-circuited, the eddy current of load 10 is not limited in the case of small current measuring range, and the load current is quickly stabilized to a constant value. In addition, since the load current is

not limited, the saturation of operational amplifier 14 and current booster 26 inside the constant voltage circuit 12 does not happen.

Once the time needed for the load current to be stabilized from the time of charging voltage has passed, the short-circuiting lead relay RY_n is opened by the relay control circuit 30, and the voltage proportionate to the load current is produced as the output voltage V_3 from the operational amplifier 34. Thus, the load current is measured.

Accordingly, in the case of capacitive load also, the load current is stabilized to a constant value quickly, so the current measuring can be performed quickly by properly controlling the time to close the short-circuiting lead relay RY_n.

In addition, controlling the lead relay $RY_1 - RY_m$ for switching the measuring range may be done while the short-circuiting lead relay RY_n is closed.

Fig. 2 shows a circuit diagram of other embodiment example of the current measuring circuit of the present invention. In this figure, the reference numbers shown in Fig. 1 indicate the same components.

In the current measuring circuit in this example, the current detection resistors, $R_{11} - R_{1n}$, are serially connected, and by selectively short-circuiting the resistors, $R_{12} - R_{1n}$, by the lead relays, $RY_{11} - RY_{1m}$, the

measuring range can be switched. The short-circuiting lead relays RY_{1n} are connected in parallel between the output terminal of current booster 26 and the load connection terminal 28, as shown in the figure.

The structure other than said portion is the same as that in the aforementioned embodiment example.

With this current measuring circuit also, it goes without saying that the current of the capacitive load can be measured by temporarily closing the lead relay RY_{1n} while the eddy current is flowing to the load 10, as in the case with the aforementioned example.

Two embodiment examples were explained above, but application of the present invention is not limited to these examples; the present invention can be embodied to a properly modified example within the scope of the gist of the present invention.

In addition, a measuring circuit aiming at measuring the resistor value of load by the load current is, likewise, the embodiment of the present invention.

(Advantage of the Present Invention)

As explained above with reference to the embodiment examples, in the current measuring circuit of the present invention, a current detection resistor is inserted in the current path serial to the load contained in the

constant voltage loop circuit for charging the constant voltage into the load; the load current is measured by the voltage drop in the current detection resistor; a switching element is installed for short-circuiting the current detection resistor inserted in the aforementioned current path; therefore, a current measuring circuit that can prevent the saturation of an operational amplifier and of a current booster inside a constant voltage loop circuit and that can perform the load current measuring quickly can be implemented even the load is capacitive and has a low current range.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 indicates a circuit diagram indicating one embodiment example of the current measuring circuit of the present invention. Fig. 2 indicates a circuit diagram of other embodiment example of the current measuring circuit of the present invention.

10. load

12. constant voltage loop circuit

14, 22, 34, 36. operational amplifiers

26. current booster

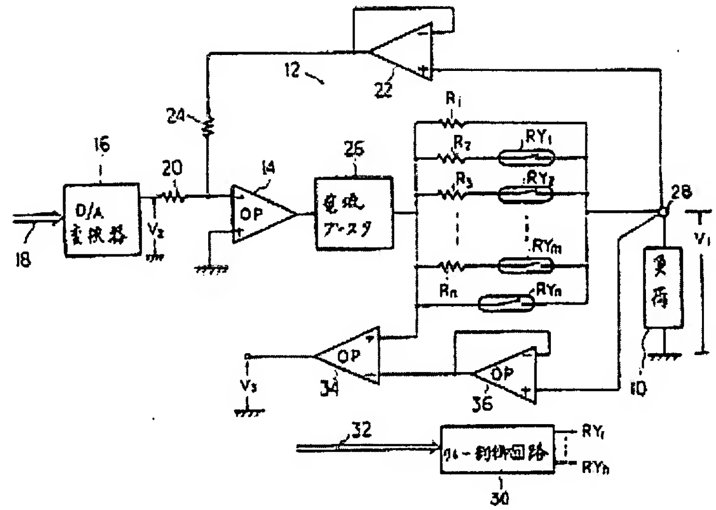
$R_1 - R_n$, $R_{11} - R_{1n}$. current detection resistors

$RY_1 - RY_m$, $RY_{11} - RY_{1m}$. lead relay for switching the measuring range

RY_n, RY_{1n}. lead relay for short circuiting (switching element)

30. relay control circuit

第 1 図



第 2 図